

REMARKS

This application has been carefully reviewed in light of the Office Action mailed on May 9, 2003. Claims 22 and 29 have been amended. Claims 58 and 59 have been added. Claims 22-35 and 58-59 are now pending. Reconsideration of the above-referenced application in light of the amendments and following remarks is requested.

Claims 22-35 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Chiang in view of Moslehi. Reconsideration is respectfully requested.

Chiang does not teach or suggest “forming a heat-radiating layer on an upper surface portion of said copper conductor, said heat-radiating layer comprising a continuous layer of aluminum nitride passifying said upper surface portion of said copper conductor,” as recited in claim 22, or “forming a heat-radiating layer comprising aluminum nitride on an upper surface portion of said conductor, said aluminum nitride layer providing a heat dissipating path for said conductor,” as recited in claim 29. In fact, Chiang does not teach or suggest a heat-radiating layer comprising aluminum nitride as recited in claims 22 and 29.

To rectify this deficiency in Chiang, the Office Action asserts that Moslehi teaches “the method of forming the heat radiating passivation layer of aluminum nitride.” (Office Action, pg. 5), and thus can be employed as a passivation layer in Chiang. Applicant respectfully disagrees.

Chiang teaches a “silicon oxynitride passivation layer 80” provided over a portion of a contact plug 61 and a titanium nitride barrier layer 60 on the sidewalls and bottom of the contact plug 61, (Col. 8, lines 10-68, Col. 9, lines 49-50) and that “the copper within the interconnects [contact plug] is encapsulated to prevent copper diffusion into a silicon dioxide layer,” and that “[t]itanium nitride and silicon oxynitride act as diffusion barriers to the copper.” (Col. 10, lines 9-15) (emphasis added).

Moslehi teaches a “free-space ILD/IMD structure . . . [thereby eliminating] the need for the use of diffusion barrier layers to encapsulate the metallization structure at each interconnect level.” (Col. 8, lines 25-31) (emphasis added). Thus, “copper can be deposited directly on the patterned structure without a need for a diffusion barrier layer.” (Col. 12, lines 26-28) (emphasis added).

Significantly, Moslehi does not teach or suggest the use of AlN to prevent the diffusion of copper into a surrounding material, and specifically, does not teach use of AlN to prevent copper from diffusing into silicon dioxide and silicon, which is the very purpose of Chiang’s silicon oxynitride passivation layer. The teachings in Moslehi simply do not relate to the problem addressed in Chiang: preventing the diffusion of copper in an interconnect structure.

Moslehi may generally suggest that AlN films have been used as a passivation layer in integrated circuits; however, there is no motivation to use the Moslehi AlN film to passivate the contact plugs of Chiang, where the passivation layers in Chiang act as copper barriers. Stated otherwise, there is no motivation to substitute an AlN layer, taught by Moslehi, for the silicon oxynitride passivation layer of Chiang to prevent diffusion of copper into surrounding structures.

The Office Action asserts that “the fact that the two references are teaching inventions that solve two different problems does not mean that the references are not combinable.” (Office Action, pg. 3). However, Applicant respectfully submits that since these two references solve different problems, there is no motivation to combine the references.

It is clear that the cited references are directed to solving different problems. Chiang is directed to methods of providing a structure that can utilize copper interconnects. Chiang provides a structure that encapsulates copper 61 with barrier layers 60 such that the copper 61 does not diffuse out into the semiconductor device (Col. 2., lines 48-52). Moslehi is directed to providing methods of forming a structure that does

not use barrier layers. In fact, Moslehi teaches that “all via-level barrier layers can be eliminated.” (Col. 7, lines 48-53). One skilled in the art would not look to Moslehi since it solves a completely different problem than Chiang solves.

The Office Action asserts that, “it would have been obvious . . . to form the passivation layer of aluminum nitride as Moslehi teaches in order to form a passivation layer that has the advantage of high thermal conductivity.” (Office Action, pg. 3). Applicant respectfully disagrees.

Once again, there is no motivation to combine Chiang and Moslehi. Moslehi teaches that “a helium-filled free-space medium . . . provides a much superior heat transfer medium.” (Col. 15, lines 45-47). The presence of the ILD/IMD dielectric free-space region facilitates superior heat transfer and not the top passivation layer itself. Chiang does not teach an ILD/IMD dielectric free-space region. Accordingly, there is no motivation in Chiang to use Moslehi’s AlN layer.

Moreover, the Office Action even acknowledges that, “it is the helium filled free space and passivation layer (including the AlN layer) that can be considered the heat-radiating layer.” (Office Action, pg. 3) (emphasis added). Chiang does not teach a helium filled free space region. As a result, there is no motivation to use Moslehi’s AlN layer since the combination of the helium filled free space and Moslehi’s passivation layer provides the heat-radiating effect.

For at least these reasons, independent claims 22 and 29 are allowable over the cited references. Claim 23-28 depend from claim 22 and should be allowable for at least the same reasons as for allowance of independent claim 2. Claim 30-35 depend from claim 29 and should be allowable for at least the same reasons as for allowance of independent claim 29.

The Office Action asserts that “Moslehi also discloses the method wherein the aluminum nitride is a thickness of approximately 300 angstroms (see column 14, lines 20-

23)." (Office Action, pg. 5). Applicant respectfully disagrees.

Moslehi teaches that the aluminum nitride is formed to be "at least a 5000 Å thick layer of insulating material." (See Col. 15, lines 2-15) (emphasis added). The cited reference's aluminum nitride layer is thicker by a factor of at least 15 than Applicant's claimed aluminum nitride layer. Moslehi does not teach an aluminum nitride layer that is approximately 300 Å thick as recited in claims 25 and 32.

Moreover, column 14, lines 20-23 teach the first layer of the top hermetically sealing layer and that "the preferred material is silicon dioxide" formed to a thickness of "50 Å to 200 Å." (Col. 14, lines 20-24) (emphasis added). Applicant's claimed AlN layer is at least 100 Å thicker than Moslehi's layer, even assuming *arguendo* that column 14, lines 20-23 teach an AlN passivation layer, which it does not. Stated in another way, Moslehi's alleged 200 Å AlN layer taught in column 14, lines 20-23 is at least 33% thinner than Applicant's claimed AlN layer's thickness of 300 Å. This is a significant difference in thickness and would not be a matter of routine optimization as the Office Action claims.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

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